Doubly cHarged Higgs at the LHC in 3-3-1 model

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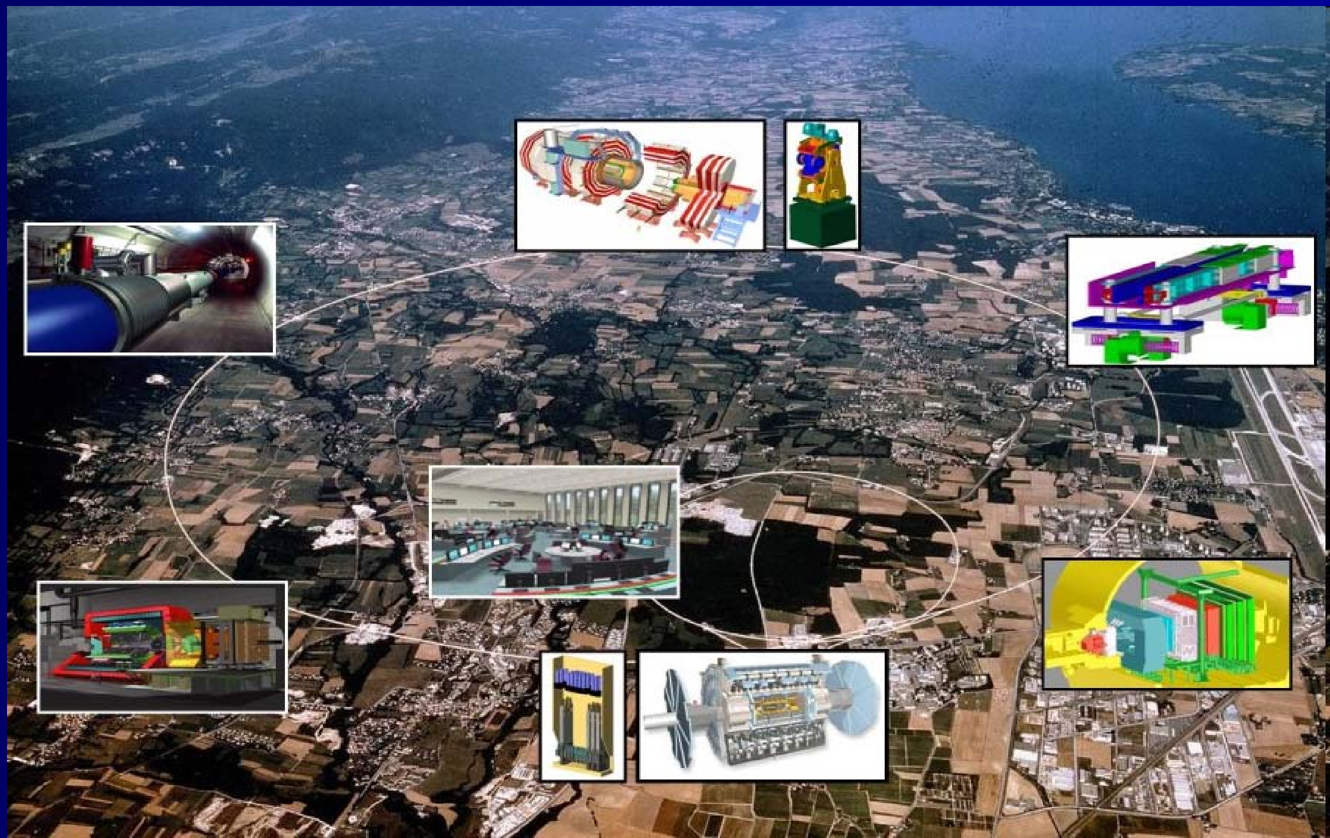


Charged Higgs 2008,Uppsala-Se

INTRODUCTION

* SM is impressively successful in describing the existing experimental results.

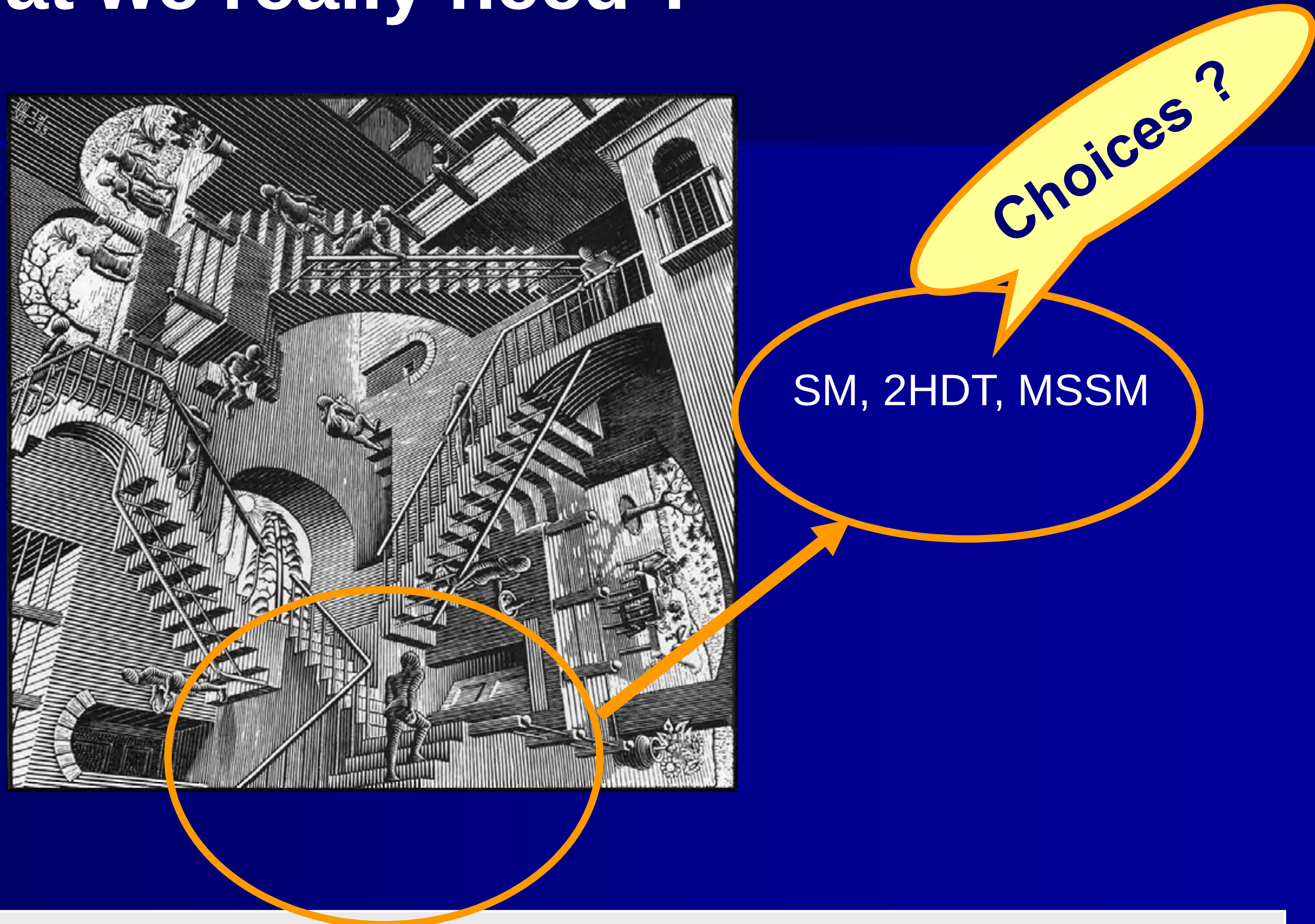
* SU (3) x SU (2) x U (1) gauge group.

* BUT it presents open questions without solutions !!

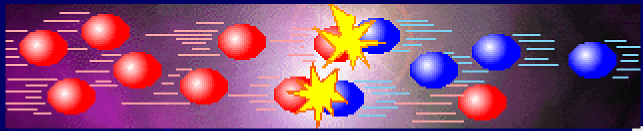
A FÉ vai contra o senso comum do que é ciência ?

O APARENTE PARADOXO da FÉ no SENHOR DEUS

What are we looking for is what we really need ?



Are we looking for in the right direction , or at least could it be more complete ?



The good but old SM ...

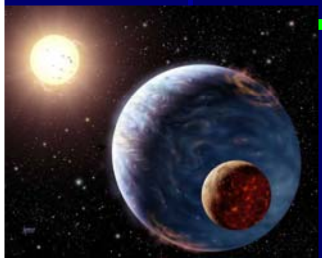
CP Violation

Generation replication problem

It does not prevent

physics

in Tev scale



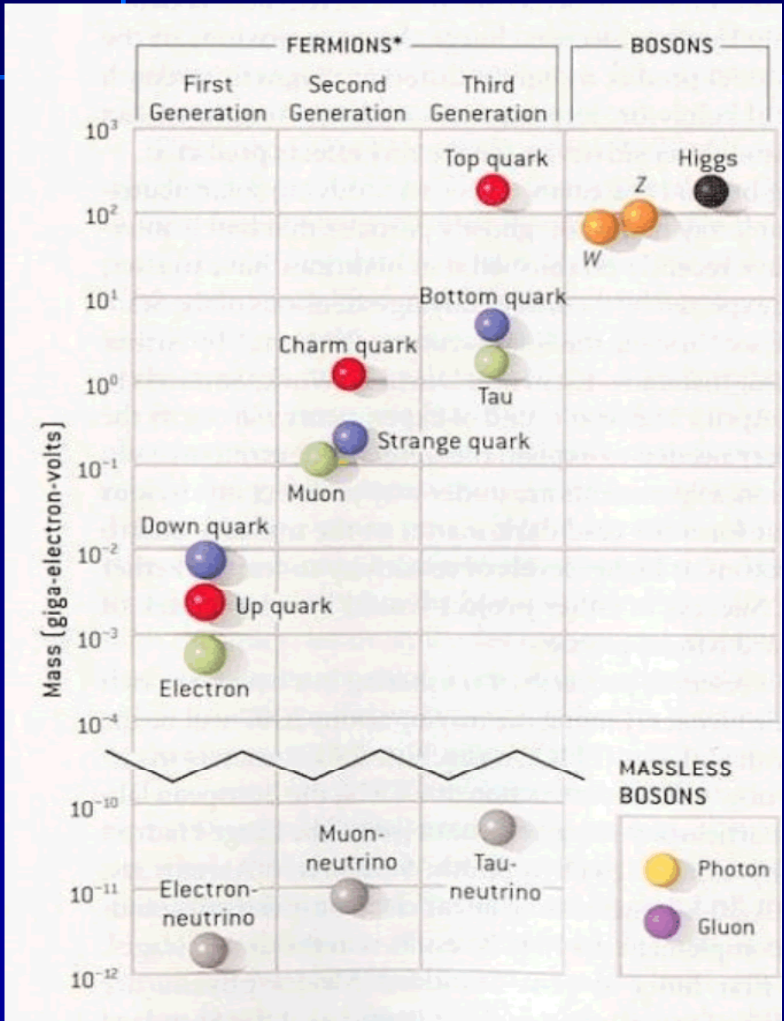
NEUTRINO

MASSES

Weinberg angle value

Other features and problems

Would you like new PARTICLES ?



$H(1\text{-}3)$ h $H^{\pm}(1\text{-}2)$

$J1\text{-}3$

$H^{\pm\pm}$

Z' $V^{\pm}$ $U^{\pm\pm}$

E M T

Among the alternatives to SM, we have:

. Enlarge the gauge group;
. Supersymmetric extensions;
. Superstrings inspired models;
. Others.

* One of then is the 3-3-1 model class.

. They have interesting possibilities
for the physics at the TeV scale.

And it is a quite simple quiral model.

The 3-3-1 Model

$$SU_L(3) \otimes U_N(1)$$

Pisano-Pleitez-Frampton Model

Phys.Rev.D 46:410-417,1992

Phys.Rev.Lett.69:2889-2891,1992.

(each one has > than 300 citations in Spires).

* At low energies they coincide with the SM

They explain some fundamental questions:

- Due to cancelation of chiral anomalies, the number of generations N must be a multiple of 3, however due to asymptotic freedom in QCD, which impose that the number of generations must be N <= 5, the unique allowed number of generations is N = 3;

- some versions predicted the mixing weak angle.

- The electric charge is quantized independent of the nature of the neutrinos (Majorana/Dirac)

- The fact that one generation of quarks is treated differently from the others, could lead to an explanation of the heavy top quark mass.
-

The seesaw mechanism can be naturally incorporated in some version of the 3-3-1 models

The models are non-perturbative at TeV scale, as well as the supersymmetric version.

* There are some versions of 3-3-1 model . They depend of the choice of the parameter β in the electric charge operator:

$$\frac{Q}{e} = \frac{1}{2}\left(\lambda_3 - \beta\lambda_8\right) + X$$

Where λ are the Gell-Mann matrices and X is the U(1) charge.

The minimal scalar sector contains the three triplets:

$$\langle\eta^0\rangle = v_\eta, \langle\rho^0\rangle = v_\rho, \langle\chi^0\rangle = v_\chi, v_\eta^2 + v_\rho^2 = v_W^2 = (246\ \text{GeV})^2.$$

The left-handed lepton matter content transforms as:

$$\left(\upsilon'_a \quad l'_a \quad \text{X}'_{a,L}\right)^T \sim (3\ ,\ 0)\ \ ,\ \text{where a = family index.}$$

Symmetry Breaking

$$SU(3)_L \otimes U(1)_N \xrightarrow{<\chi>} SU(2)_L \otimes U(1)_Y \xrightarrow{<\eta,\rho>} U(1)_{em}$$

$\varphi = v_\varphi + \xi_\varphi + i\zeta_\varphi$ $\quad (v,\ u,\ w) \quad v^2 + u^2 = v_W^2 \quad w \gg u, v$

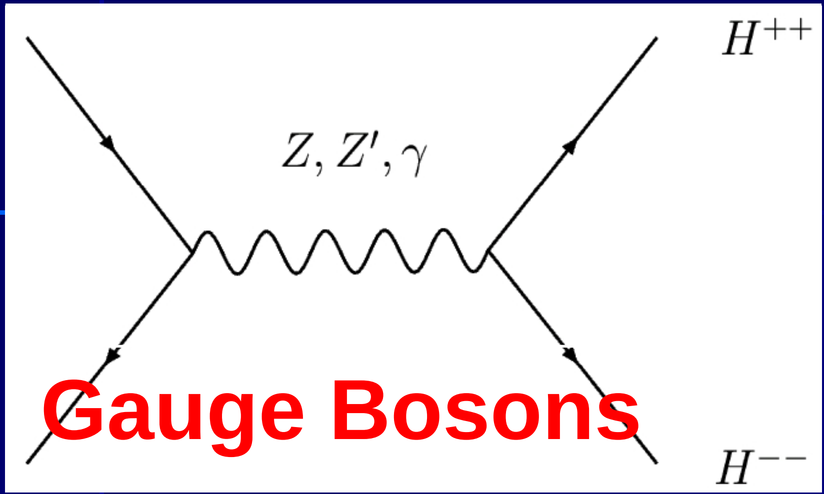
Neutral Sector $\quad H_1^0 \ H_2^0 \leftrightarrow \xi_{\eta,\rho} \qquad H_3^0 \leftrightarrow \xi_\chi$

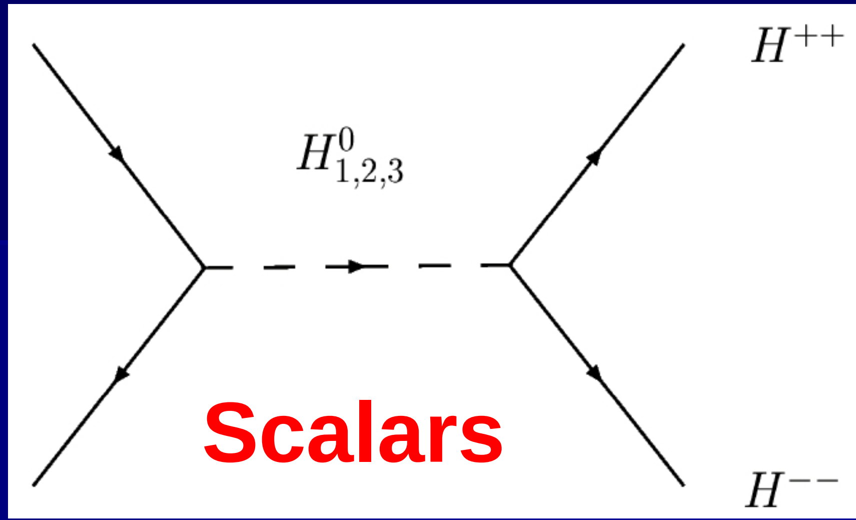
Charged Sector $\quad H_1^+ \ H_2^+ \leftrightarrow \xi_{\eta,\rho,\chi}$

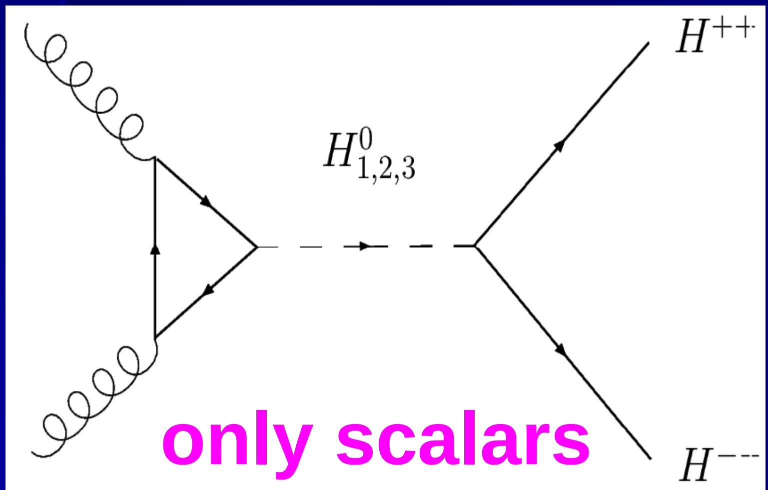
$H^{++} \leftrightarrow \xi_{\rho,\chi} \qquad \dfrac{u^2 + w^2}{2vw}(fv - 2\lambda_9 uw)$

The Production of Doubly Charged Higgs at LHC in the 3-3-1 Model

Drell-Yan Mechanism







Gluon-Gluon Fusion

Exotic Particles Masses (em GeV)

E	M	T	J_1	J_2	J_3	Z'	V	U
190	1140	2600	1300	1030	1830	2200	600	600

Parameters

$v_\eta = 195\ GeV$ $v_\chi = 1300\ GeV$

λ_1	λ_2	λ_3	λ_4	λ_5	λ_6	λ_7	λ_8	λ_9
-1.2	-1.	-1.	-2.84	-1.57	1.	-3.	-1.	-1.

Quark loop contribution

$$from\ \ H_3^0$$

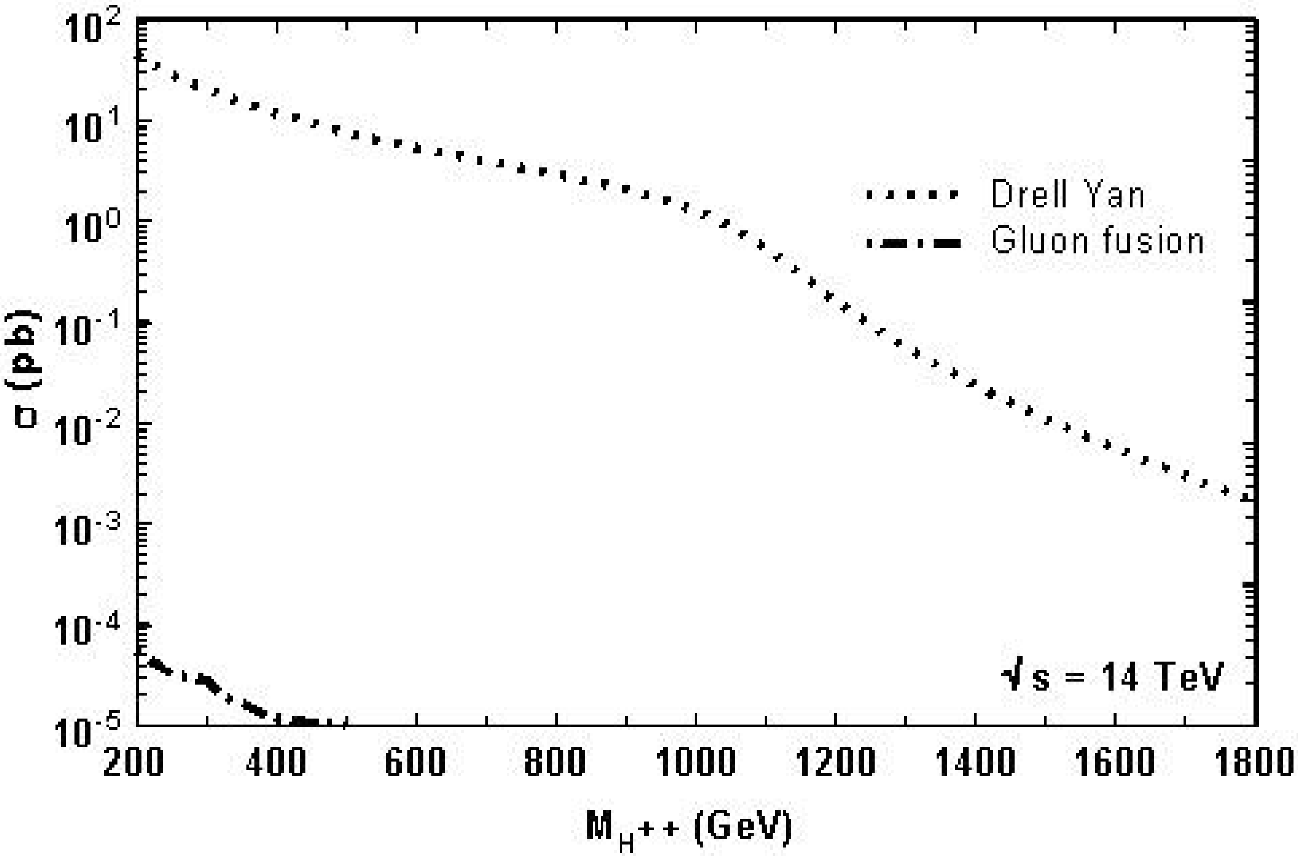
$$\sigma = \frac{\beta_{H^{++}}}{(32\pi^2)^2}\left(\frac{\alpha\ \Lambda\ \xi}{\mathrm{s}}\right)\left|\sum_J \Lambda_J M_J^2\left(2-\beta_J^2\right)I_J\right|^2$$

Λ quark and scalar couplings

$\beta = \sqrt{\frac{s-4M^2}{s}}$ for the scalar and the quarks

$$I_J = \int_0^1 \frac{dx}{x}\ \ln\left[1-\frac{(1-x)\,sx}{M_J^2}\right] \qquad I_J = \frac{1}{2}\ \ln^2\frac{\beta_J-1}{\beta_J+1}$$

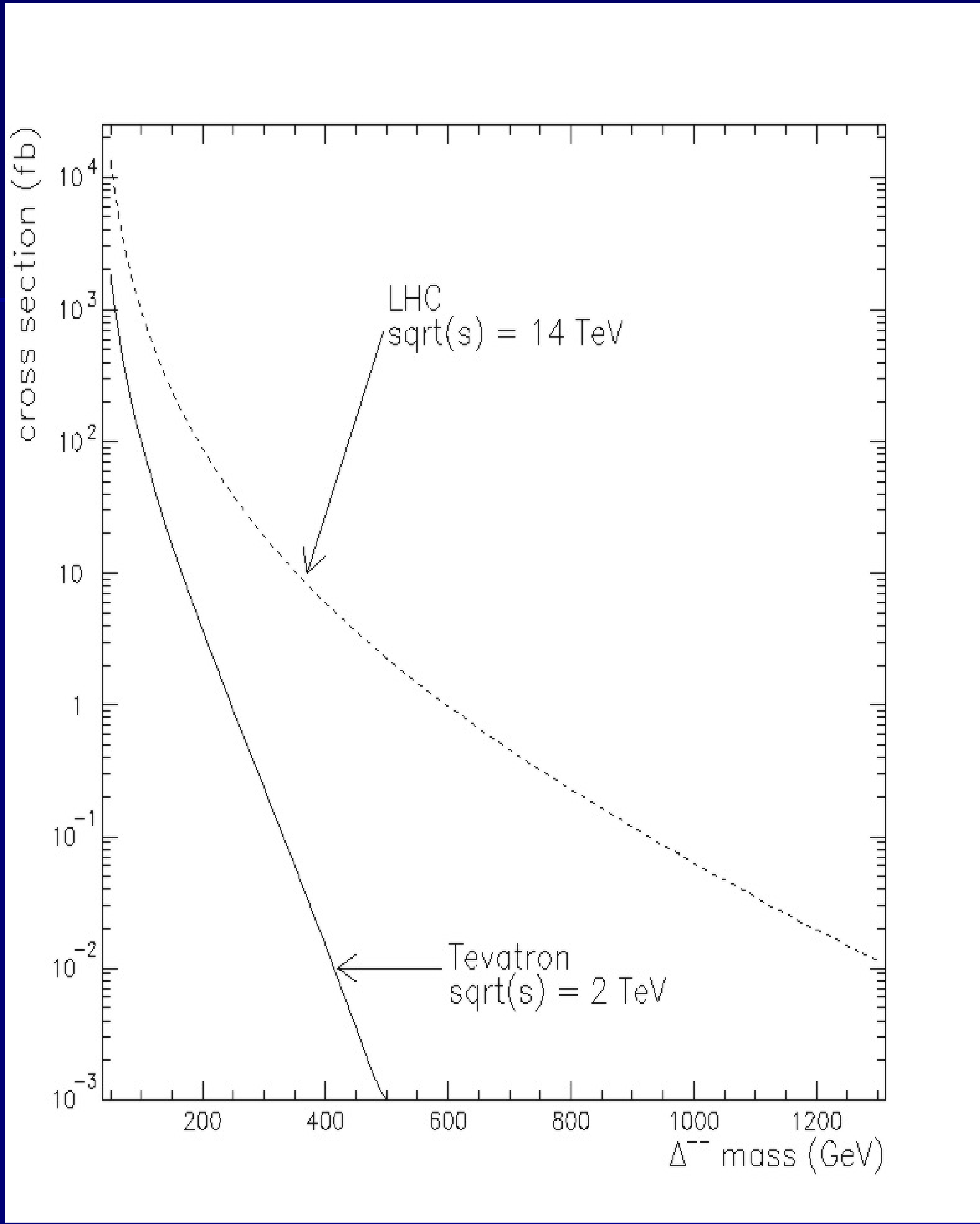
DCHB x Drel Yan x GGF



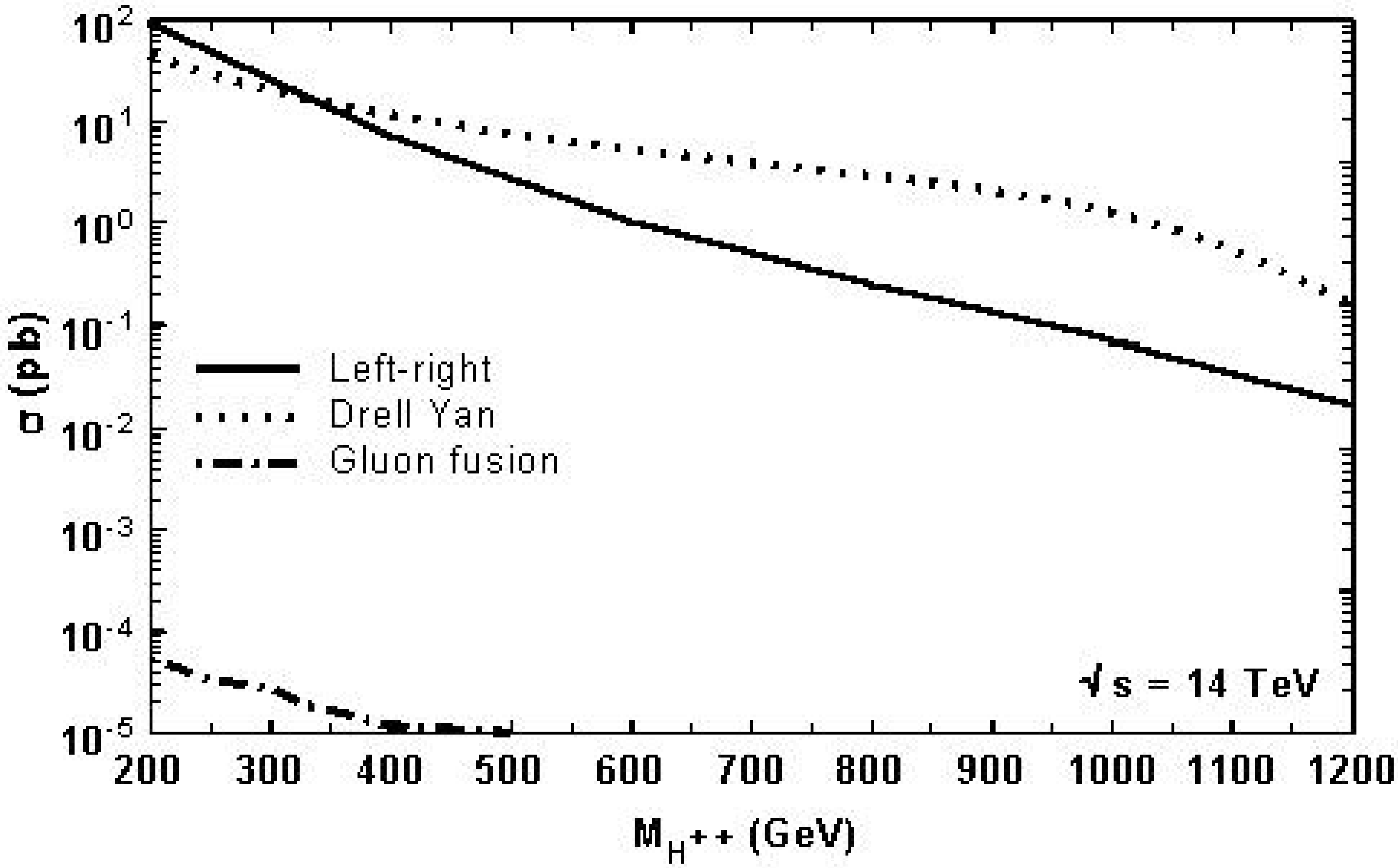
Left-Right

Symmetric Model

LHC x Tevatron



LRSM x 331(DY) x 331(GGF)



Branching Ratios

$$M_{H^{++}} = 1300\ GeV$$

$H^{\pm}$	H^{--}		H^{++}		$H^{\pm\pm}$			
qJ	$l^{-}E^{-}$	$l^{-}M^{-}$	$l^{+}E^{+}$	$l^{+}M^{+}$	$U^{\pm\pm}H_1^0$	$V^{\pm}H_1^{\pm}$	$U^{\pm\pm}\gamma$	$U^{\pm\pm}Z$
0.001	0.08	0.005	3.0	6.0	2.0	19.0	29.0	444